DOE Business Plan for the Office of Science's Ames Laboratory

Mission and Overview

The Ames Laboratory (Ames) was formally established in 1947 and became part of the Manhattan Project after developing the most efficient process to produce high-purity uranium metal in large quantities for atomic energy. Today Ames' mission focus of materials science, engineering, analytical instrumentation and chemical sciences provides expertise to the Department of Energy laboratory system in the areas of energy, environmental improvement, and human health. Ames operates the Materials Preparation Center (MPC) which provides capabilities in preparation, purification, fabrication and characterization of materials in support of R&D programs throughout the world. Ames also collaborates with the DOE's applied energy technology and nonproliferation programs and supports the National Institutes of Justice, National Institutes of Health, Department of Defense, FBI, and corporate entities. Since 1984 Ames Laboratory has received 15 R&D 100 awards from R&D Magazine, which selects the 100 most significant technical products and innovations each year. Over 2900 Masters and Ph.D. degrees in science and engineering have been awarded to Ames students since 1947.

Laboratory Focus and Vision

Five areas of core competency underpin activities at Ames Laboratory:

1. Materials design, synthesis and processing
2. Analytical instrumentation/device design/fabrication
3. Condensed matter theory (including photonic band gap and other novel materials)
4. Materials characterization, x-ray and neutron scattering, solid-state Nuclear Magnetic Resonance (NMR), spectroscopy/microscopy
5. Separation science.

The Office of Science believes that these five competencies will enable Ames to deliver its mission and customer focus, to perform a complementary role in the DOE laboratory system, and to pursue its vision for scientific excellence and pre-eminence in the areas of:

- Fundamental materials research with emphasis in optical magnetic, intermetallic, and catalytic materials; and studies of the structure and properties of high temperature materials.
- Analytical techniques and instrument development.

Lab-at-a-Glance

Location: Ames, IA

Type: Single-program laboratory

Contract Operator: Iowa State University (ISU) of Science and Technology

Responsible Field Office: Ames Site Office

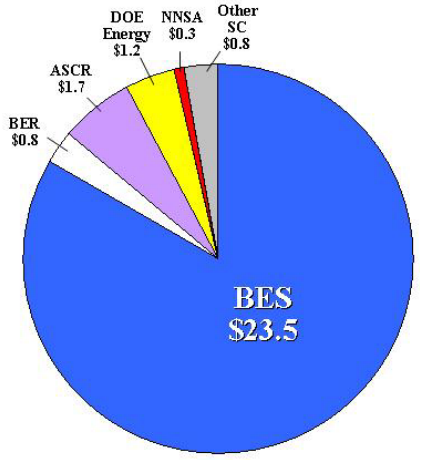
Website: http://www.Ameslab.gov/

Physical Assets:
- 12 buildings
- 10 acres (lease–long term, no cost)

Human Capital:
- 320 Full-time equivalent employees;
- 185 ISU grad/undergrad students
- 140 Facility users, visiting scientists, and associates

FY 2005 Total DOE Funding: $28.2M

FY 2005 DOE Funding by Source
PALS data (BA in Millions):



FY 2005 Non-DOE Funding: $3M

Business Lines

The following capabilities, aligned by business lines, distinguish Ames and provide a basis for effective teaming and partnering with other DOE laboratories, universities, and private sector partners in pursuit of the laboratory mission. These business lines and the distinguishing capabilities outlined in the table below provide an additional window into the mission focus and unique contributions and strengths of Ames and its role within the Office of Science laboratory complex. Items in italics within the column, Distinguishing Capabilities, identify research facilities that convey particular, strategic strengths and capabilities to the Lab. Descriptions of these facilities can be found at the website noted in the Lab-at-a-Glance section of this Plan.

Business Lines	Distinguishing Capabilities	Distinguishing Performance	Mission Relevance
Primary Business Line			
Fundamental Materials Research	• **Novel optical materials;** • **Materials preparation, synthesis and processing;** • **Magnetic materials and correlated electron systems;** • **Complex intermetallic compounds;** • **Catalytic materials;** • *Materials Preparation Center;* • *Materials Referral System and Hotline;* • *Scalable Computing Lab.*	Leader in photonic band gap materials and super lenses; Recognized world leader in rare earth and intermetallic compounds; Materials Preparation Center (MPC); Pioneering work on Environmentally-benign refrigeration and magnetic molecules; Leader in quasi-crystals; properties of complex materials; Pioneering work on novel structures; high-specificity reaction, controlled drug release.	Advance Basic Sciences for Energy Independence Synthesis and characterization of the next generation of materials for energy efficiency/storage, communications, and environmental stewardship.
Secondary Business Line			
Analytical Techniques and Instrument Development	• **Mass spectrometer techniques and instrument design;** • **Single-cell analyses;** • **Single-molecule analyses;** • **Electrochemically modulated liquid chromatography;** • **Surface-enhanced Raman scattering;** • **Solid-state Nuclear Magnetic Resonance (NMR) for heterogeneous polymers.**	Record of internationally recognized excellence: inductively-coupled plasma – mass spectrometer (ICP-MS) in every analytical lab in world; biomolecule analysis; Pioneering work in fundamentals of cellular physiology; disease diagnosis, treatment; Studying reactivity at single molecule level; Largest concentration of internationally acclaimed researchers focusing on greater precision in nanostructure analyses.	Provide the Resource Foundations that Enable Great Science Development of techniques for characterization of novel materials and rapid, sensitive detection of chemicals and biomaterials for applications ranging from bioremediation to national security.

Major Initiatives

Following is a set of major initiatives that could be pursued at Ames that support critical aspects of the Office of Science mission and build on core strengths and capabilities of the laboratory. The Office of Science is examining all of these potential initiatives and they are at different stages of development. Some are currently underway and some are mere concepts at this time. For those that are still in the conceptual phase, Ames has indicated significant interest and is viewed to have current supporting research and mission focus to pursue such initiatives. Budgets, the Office of Science's strong commitment to a fair and competitive funding process and technical advice from its major scientific advisory committees will ultimately contribute to

decisions about which initiatives can be pursued and at which sites. The companion documents, the DOE's Five Year Plans, provide greater insights into these initiatives in terms of OMB five year targets.

The major initiatives are:

1. Bioinspired Materials
2. Materials Discovery, Synthesis and Processing
3. Distributed Electrostatic Levitation User Facility

1. Bioinspired Materials

- **Summary:** Synthesis and characterization of novel materials that mimic living systems.

  Expectations: Materials will be designed and synthesized that possess the ability to: switch among several states in response to the environment (pH, temperature); self-assemble and build complex structures hierarchically; and serve as directed templates for such synthetic processes as biomineralization/biometallization.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Moderate risk.* This research area is quite new so there is a high degree of uncertainty.
  - Market/Competition: *Moderate risk.* It is too early to determine the market/competition risk, however, certainly development of self-assembling materials is widespread in the research community.
  - Management/Financial: *Moderate risk.* This will be a new direction for the Materials Chemistry Program. The Program is currently in a transitional period where some of the current research efforts must be phased out, as new bioinspired efforts are commenced.

Ames Laboratory management has decided to direct significant efforts and resources to the synthesis and characterization of novel materials that mimic living systems. These materials possess the ability to switch among several states in response to the environment and to self-assemble into complex structures. Ames believes that the rational design of such self-assembling systems will become a very significant part of materials science. A current project that demonstrates the power of this approach is to process the self-assembled polymers with other self-assembling components, in this case mineralization proteins, for the synthesis of a very interesting class of materials, nanomagnets. Over the next several years, Ames expects to build and strengthen this overall program in support of the DOE mission and in keeping with the future vision for the laboratory. This building process will involve creating teams of bioengineers, theorists, synthetic chemists, biologists and experts in chemical characterization, and will require the combined scientific strengths of the Lab and its contractor and collaborator, Iowa State University.

2. Materials Discovery, Synthesis and Processing (MDSP)

- **Summary:** Comprehensive enhancement of facilities and collaborations in materials discovery, synthesis and processing to maintain U.S. world leadership.
- **Expectations:** Enhancing facilities, staff and external collaborations to train the next generation of materials scientists in MDSP.
- **Benefit Perspective:** Potentially *Substantial*/*Sustaining* benefits
- **Risk Perspectives:**
  - Technical: *Low risk.* The Ames Laboratory Materials Preparation Center is known worldwide for providing high purity materials for research. In addition, Ames arguably has two of the very

best "crystal-growing groups" in the world.

- Market/Competition: *High risk.* Competition in the area is strong worldwide.
- Management/Financial: *Low risk.* Ames Laboratory already has the management in place, the scientists on hand, and the university nearby to accomplish the goals of the initiative. Also, the desired additional investment from DOE is relatively small.

Late in 2003, the DOE's Basic Energy Sciences program sponsored a national workshop, held in Ames, Iowa, to discuss the declining dominance of the U.S. effort in design, discovery and growth of novel materials for basic research relative to the competition, specifically Europe and Japan. The conclusion was that DOE should act quickly to strengthen the Nation's efforts in this arena "by adding qualitatively new capabilities, and by significantly enhancing Ph.D. and postdoctoral training opportunities. . . ." Ames Laboratory has the physical and intellectual infrastructure to lead in this DOE materials effort. For example, the strong connection between Ames and its contractor, Iowa State University, positions the Lab to enhance Ph.D. and postdoctoral training. A relatively modest increase in funding for this initiative will enable the Lab to establish new outreach programs and collaborations with universities, laboratories and industry across the country and to increase staffing and add new research programs in the relevant areas at Ames. Without this and similar initiatives elsewhere in the laboratory complex, the Nation is unlikely to remain a world leader in materials research, giving way to Germany and Japan which see considerable strategic advantage to strong materials programs and are investing great resources into world-class programs at this time.

*3. **Distributed Electrostatic Levitation (ESL) User Facility***

- **Summary:** Implement a new concept in user facilities for fundamental investigations of intrinsic materials properties and structures at high temperatures.
- **Expectations:** A unique facility for pioneering studies of solids and liquids at high temperatures. The benefits of this research could be transformational since the efforts will be focused on exploration of materials properties under conditions that are currently inaccessible.
- **Benefit Perspective:** Potentially *Transformational* Benefits
- **Risk Perspectives:**
  - Technical: *Low risk.* The technology has been used by Ames in the past, but access to the NASA ESL has been limited.
  - Market/Competition: *High risk.* Currently, Japan has built an ESL facility and Germany is in the process of building one.
  - Management/Financial: *Moderate risk.* A risk and also a benefit exists from the standpoint that two of these devices will be located at other national laboratories. From a financial standpoint this initiative is too large for current Ames funding to be redirected.

This facility enables an important new class of investigations of the high temperature structure and properties of materials by removing the constraints of containment in vessels. Recent advances in electrostatic levitation (ESL) have made this possible, but unfortunately the only two ESL units in the U.S. are not available to the growing list of potential users. This initiative involves establishing an ESL User Facility in the Ames Materials Preparation Center, coupled with ESL facilities designed for high-energy x-ray scattering measurements at the Advanced Photon Source and neutron scattering measurements at the Spallation Neutron Source. Together, the proposed facilities will provide a powerful complement of tools for fundamental studies, the discovery of new metastable phases, and advanced materials manufacturing methods. The facility would be unique in the world and would bolster U.S. dominance in the study of high temperature structure and properties of materials. Ames would serve as the operational base for these facilities with partners at major research universities, industry, other national laboratories and private foundations being actively sought to share in the cost.

Financial Outlook

Detailed information regarding the financial outlook for the Ames Laboratory is subject to 1) competition and merit review, 2) the availability of appropriated funds and 3) programmatic decisions. The first two factors can not be predicted or estimated in advance. The third, programmatic decisions, are developed in accordance with the five year planning targets provided by the Office of Management and Budget and reflected in the Department of Energy programmatic Five Year Plans, a companion document to these strategic laboratory business plans. In addition, because of the Office of Science commitment to competition and merit review, there is often a time lag between programmatic decisions and the determination of which research provider can best deliver the greatest value in conducting the research. Thus, it is not always apparent how programmatic decisions unfold for particular laboratories. Nevertheless, some decisions, such as the plans for large scientific user facilities, show clear paths to individual labs and therefore inform their business plans.

Support for Non-DOE funded work is a vital role our national laboratories, contributing to national security, energy security, environment stewardship, scientific discovery, and more fundamentally, the competitiveness of the U.S. economy. For Ames, this is no exception. The Office of Science is highly supportive of this work and although it is not addressed in any detail within the accompanying Five Year Plans, the Office of Science believes it is sufficiently important and appropriate to address within this strategic laboratory business plan. A brief perspective and financial outlook is therefore provided.

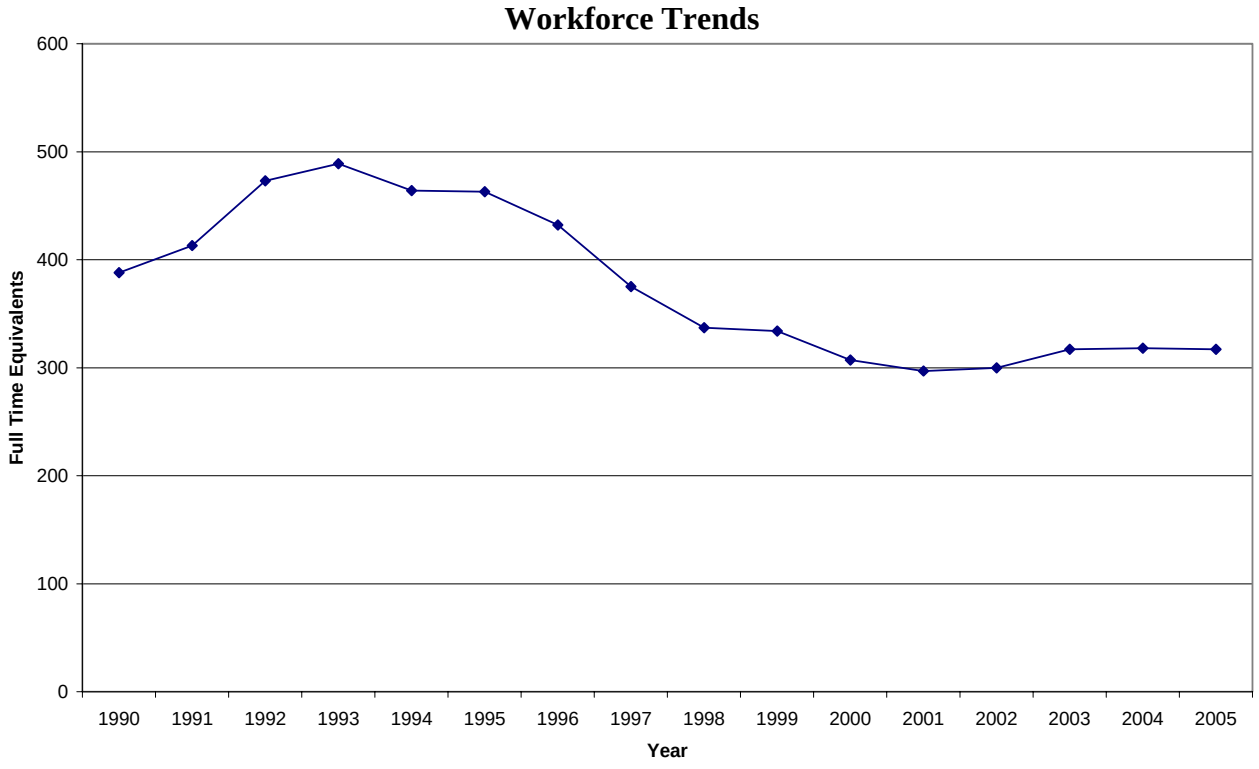
The current Ames non-DOE funded activities are primarily supported by the National Institute of Justice and the Department of Defense. The primary National Institute of Justice work is for the operation of the Midwest Forensic Resource Center, a center for advanced research and development in forensic science, whose goals are: to advance innovative technology and management practices in crime laboratories; to provide access to university and laboratory resources for use in casework; and to be a focal point for innovative training and education. Major projects for the Department of Defense include preparation and atomization for powder alloys, preparation and characterization of various alloys, and the development of research systems and software tools for virtual engineering. These two federal sponsors are expected to continue to fund projects at current levels. In addition to these sponsors, Ames has non-DOE funded work with various industrial partners, with activities ranging from designing low temperature rare earth-based magnetic regenerator materials to sharing the operational costs of the Midwest Universities Collaborative Access Team (MUCAT) sector at the Advanced Photon Source. Such industrially funded activities are also expected to continue at the current levels.

Uncertainties and Risk Management

External Factors: The critical risk facing Ames is one of adequate, stable funding and subsequent impacts on the workforce. An important source of risk mitigation for Ames is the relationship with its contractor, Iowa State University. Many of the scientists, researchers and administrators at the Lab hold joint faculty or managerial positions at the University and the Lab has access to both undergraduate and graduate student talent. The ability of the University to include the Lab in its pursuit of top faculty and the Lab to include the University in its pursuit of new scientists helps attract key personnel. The Lab also shares the following with its Contractor: employee benefits and services; environment, safety and health support; research support; operations support; and administrative support. An additional source of long-term support for Ames is its wide-ranging scientific interactions. Ames effectively partners with researchers at other DOE laboratories and facilities, including the Ames MPC, collaboration in interlaboratory SciDAC projects, collaborations with Sandia, Argonne, Lawrence Berkeley, and Lawrence Livermore National Laboratories. There are also collaborations involving industry, non-DOE labs and other government agencies. Notably, Ames is highly

successful in terms of licensing revenue ratioed to funding, and it ranks third among the DOE national laboratories in total licensing despite its small size. No key community relations issues face the Ames Laboratory.

S&T Workforce: The workforce for Ames Laboratory, in recent years, has remained relatively stable from year to year and a major reduction in force or other downsizing over the next five years is not anticipated. Any reductions that will need to be made will likely come from attrition. The projected levels of full time equivalent employees (both direct-funded research FTEs and total FTEs), over the next five years, vary based upon the funding scenarios used to establish this business plan.



Employee Diversity: Ames' staff is 0% Hispanic, 1% black and 26% female. In scientific and technical areas, 1% are black, and 16% are female. Ames recognizes that it does not come close to matching the diversity seen across the country. Because of its location, attracting minorities to Iowa has proven to be very challenging, especially in attracting those with the scientific and technical skills needed at a laboratory such as Ames. In addition, women and minority scientists are in great demand across the country, with competition

coming from other laboratories, from universities, and from industry. To improve the minority prospects, the Ames contacts a series of minority and women professional societies and universities when key openings occur.

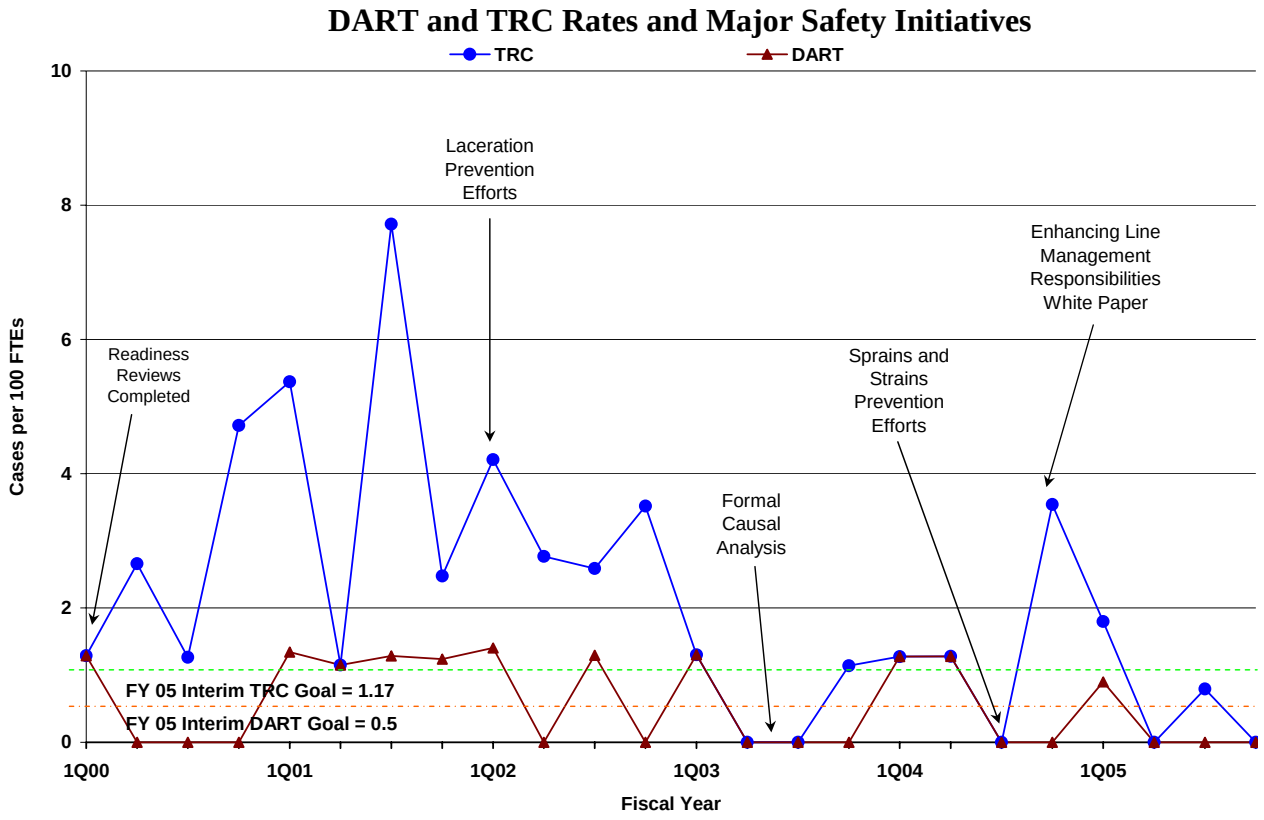
The 2015 goals for Ames in diversity are to: continue to broaden the base of applicants for job openings; increase minority participation from 0% to 4% Hispanic and from 1% to 3% black; increase women participation in the scientific and technical fields from 16% to 20%; and increase the percentage of women and minorities in senior management to 25%. Ames will expand upon a seed funding program (funded under the approved Royalty Use Plan) that targets junior faculty members, with the goal being that at least 25% of all projects funded are led by women and minorities.

In the long run, the Ames laboratory firmly believes that engaging youth in science and engineering at an early age and keeping them engaged through their college degree is the best means to provide the next generation of scientists. The laboratory is providing internships through the Student Undergraduate Laboratory Internships that strongly encourages applications from minority and women students. In addition, the laboratory and Iowa State University support Science Bound, a program to engage minority children in science and math in the Des Moines, Iowa, Public Schools. The hope is that these children will go on to pursue careers in science and engineering and become the next generation of scientists for the National Laboratories and Universities, with many choosing Ames as their place of work.

FY05 data	All Employees			All Employees					
	Male	Female	Total	Caucasian	African American	Hispanic	Native American	Asian	Total
Scientists & Engineers	223	41	264	143	3	0	0	118	264
Management & Administration	30	29	59	58	0	0	0	1	59
Technical support	16	1	17	17	0	0	0	0	17
Clerical & Secretarial	1	26	27	27	0	0	0	0	27
Other	24	7	31	31	0	0	0	0	31
Total	294	104	398	276	3	0	0	119	398

Safety: AMES safety performance has improved over the past ten years and is on-target to meet or surpass current goals. The FY2004 Total Recordable Case (TRC) rate was 1.54 (5 cases) and the Days Away, Restricted or Transferred (DART) rate was 0.62 (2 cases). The estimated FY2005 TRC rate is 0.65 (3 cases) and the DART rate is 0.22 (1 case). The Laboratory's programs of employee training, readiness review, periodic walkthroughs, formal event investigations, and targeted injury prevention efforts have improved safety performance. The continued demonstration of upper management's commitment to safety, in addition to a comprehensive Integrated Safety and Environmental Management System based on sound safety

practices and mechanisms, has become the way Ames does business. Ames expects continued improvement in safety performance.



Physical Infrastructure: Ames Laboratory consists of 12 buildings (327,000 square feet (sf)) operating on the campus of the Iowa State University (ISU) in Ames, Iowa. Embedded in the University campus allows the Laboratory to benefit from many utility services provided by ISU, such as steam, chilled water, water treatment, sewage system, landscaping, fire department, electrical and telecommunication systems, and roads without the need for Federal investment to construct, maintain, or recapitalize. The availability of these services allows the Laboratory to focus on maintaining and operating its research and support buildings. The relationship with ISU also enables the Laboratory to use space in University–owned buildings through a space usage agreement without investing in permanent space or long-term leases. Ames's Asset Utilization Index (AUI) is 0.992 (excellent).

Maintenance, recapitalization, and modernization are supported with overhead, operating, and General Plant Project (GPP) funds (projects which cost less than $5M). Ames will attain a maintenance investment level of 1.9% of replacement plant value (excellent) in FY 2006, which will be continued in FY 2007 and the outyears. Ames's deferred maintenance backlog is $1.5M, resulting in an Asset Condition Index (ACI) of 0.97 (good). The few remaining excess facilities will be cleaned and/or removed by the end of FY 2006. The GPP FY 2007 funding request is for $580,000.